THE MOSQUITO

At this season of the year when the life of all rural dwellers is made miserable by the omnipresent mosquito, it is well to consider the creature a little more carefully than we are wont, and to make ourselves familiar with its construction and its habits.

A "Guide Leaflet" on the malaria mosquito, written by Dr. B. E. Dahlgren, and published by the American Museum of Natural History in New York City, is so interesting that one almost begins to admire the insect so wonderfully formed, in each of its three stages of growth, so admirably adapted to its unfriendly mission. We are permitted, through the courtesy of Mr. George F. Sherwood, secretary of the Museum, to quote at length from this pamphlet and to reproduce two of its illustrations.

The word mosquito is the Spanish diminutive of mosca, a fly, and is correctly applied since mosquitoes belong to the order of two-winged insects or true flies. The great majority are tropical, but their range of distribution is nearly universal. About forty species have been described from the neighborhood of New York. Though most common in low and swampy districts, they are also found in high altitudes and even in Arctic regions.

Railway trains are said to be responsible for the distribution of the insects, and tracts which have been practically free from the pest are thought to have been invaded as the railroad lines opened up the country. One species occurring in Australia is supposed to have been "imported from Europe in the watertanks of some old sailing vessel." Mosquitoes are also carried by the wind.

Hawaii was free from the mosquito until 1846. Dr. E. S. Goodhue says: "It arrived as a stowaway—on board the good ship *Wellington.*"

The number of mosquitoes in a large swarm is beyond comprehension; one in Texas is said to have been three miles wide and to have required nearly five days in passing a given point. Such migrations account for the sudden appearance of the insects in areas from which they were previously absent and their equally sudden disappearance.

As a rule they are frail insects and weak flyers. In rain or winds they hastily seek shelter. The malaria mosquito (*Anopheles*) avoids places where draughts exist, and seldom flies more than a few hundred yards. As a rule it spends its entire life in the immediate neighborhood of human dwellings.

Mosquitoes are most active at early dawn or after sunset. They seem in general to avoid strong light and to prefer dark colors. The hours of daylight are spent by most species hiding in some secluded spot in a tuft of grass or a bush, while the malaria mosquito finds some dark spot indoors where it passes the day. The yellow fever mosquito flies at almost any time of day except noon.

In autumn all the males die, while the fecundated females seek winter quarters. The house mosquito may be found hibernating in dark corners of cellars, sheds, or attics; the out-of-door species in the woods or fields. Large numbers of the insects undoubtedly perish during severe winters, but, under ordinary conditions, enough survive to furnish the first brood of the following season.

The food of mosquitoes consists ordinarily of the nectar and juices of plants and fruits. This is always true of the males, whose mouth-parts are not at all adapted for stinging. In certain species neither sex seems to have any taste for blood. Mosquitoes of sanguinary taste by no means confine themselves to human or even mammalian blood, they suck with eagerness the blood of birds and reptiles whose skin they may be able to pierce. They have frequently been observed feeding upon other insects and on caterpillars. Howard asserts that they will attack small fish when these come to the surface of the water. They require water, but may exist for months without any food whatever. On the other hand, they may feed as often as they have opportunity, though several hours are required for the digestion of a full meal.

The average length of life of female mosquitoes is not less than a month or two, but hibernating females must live at least six or even eight months. The life of the males is much shorter, and may not exceed a few days in duration. The point is difficult to determine, since in captivity death may be the result of artificial conditions. To compensate for the shortness of life of the males, they greatly outnumber the females. Since a recently hatched mosquito becomes full grown in two or three days, and may lay its first batch of eggs within a week, there may be as many as a dozen or more generations in the course of a year.

The female mosquito lays its eggs, from fifty to two hundred in number, on the surface of any convenient quiet body of water. Certain mosquitoes prefer to lay their eggs on brackish water.

The egg of *Anopheles* is boat-shaped with one end somewhat pointed, the other rounded. The egg is provided on the sides with corrugated air chambers which serve as floats.

In the process of deposition the eggs of the common mosquito unite to form raft-like masses, which are known as "egg-boats" or "floats."

The eggs of *Anopheles,* however, are deposited separately, but they may be found arranged in various patterns on the surface of the water.

The eggs of some species will survive drying for two or three months, while those of others easily perish if the mud or water of the pool in which they have been laid dries up. Ordinarily mosquito eggs are not resistant to cold and will not survive freezing.

When the eggs are ready to hatch, in about two to four days after they are laid, a small cap-like portion of the envelope bursts off at the rounded end of the egg and the larva escapes.

Mosquito larvæ are popularly known as "wigglers" or "wrigglers," because of their peculiar motions in swimming. As soon as freed from the egg the larva begins to feed. It grows rapidly, and, if the food supply is abundant and the temperature of the water is not too low, it attains its full size in a few days. Legs are absent, but both thorax and abdomen bear a great number of symmetrically placed pairs of branched feather-like hairs, arranged in a manner characteristic of the species. These hairs project laterally and aid in maintaining equilibrium, but they undoubtedly serve other purposes too, being also organs of touch and possibly of respiration.

The next to the last segment bears on its upper side the short "siphon," which reaches the surface of the water, when the larva floats in its usual position. In the siphon are the openings of the two main tracheæ, or respiratory tubes. The larva is strictly air-breathing and does not normally remain away from the surface of the water, except when disturbed, and then only for a short time. That the larva must have air in order to live makes possible its destruction by means of a film of oil spread on the surface of the water. The oil, acting mechanically, closes the openings in the respiratory siphon and causes the larvæ to die from suffocation.

The larva feeds with its head upward. The moustache-like brushes, by rapidly sweeping the under side of the surface film of the water, set up a current which carries food into the mouth. Small particles which become entangled in the brushes are combed out by stout curved hairs, three or four of which are borne on each mandible. Little discrimination seems to be exercised in the choice of food, though it consists principally of microscopic animals and plants.

The larvæ of certain mosquitoes may remain throughout the winter frozen in ice, coming to life in the spring.

When pools in which the wrigglers live dry out, the larvæ usually perish in a short time. They are most likely to be found in small and undisturbed bodies of water, such as accumulate in little hollows between

tufts of grass, in meadows, or in ditches where there is no perceptible flow. Where there is any current in the water the larvæ are easily swept away, and those that occur in moving water are always found along the edges of the stream, where they are out of reach of the current. Cat-tail swamps are said to be practically free from mosquito larvæ, probably because of the usual presence in them of small fish. Such places as neglected tin cans or broken bottles, rain barrels, cisterns, and deep wells may be swarming with larvæ. Dr. Howard mentions a case where the census of the inhabitants of a rain barrel was taken. In one month it yielded 36,369 mosquito eggs, larvæ, and pupæ.

The duration of the larval stage is usually from seven to fourteen days. During this time the various parts of the adult insect are in process of formation under the larval skin.

The pupa which escapes from the larval skin forms the next stage in the development of the insect. It too is aquatic in habit and ordinarily leads a brief and comparatively quiet life. It does not feed. When at rest, it floats at the surface of the water, breathing through a pair of funnel-like tubes. It is, however, able to execute very rapid, though jerky, movements and darts downward instantly when disturbed. If confined in a glass vessel, it may be seen on such occasions to strike the bottom repeatedly, returning to the surface of the water by its own buoyancy as soon as its movements cease. The downward swimming is accomplished by a few vigorous strokes of the strongly curved abdomen, which bears at its tip a pair of "paddles," or "flippers," and is the only freely movable part of the body. In respect to the position of its respiratory openings, the pupa differs decidedly from its predecessor, the larva, which has its siphon near the end of the abdomen. Like the larva, it is easily destroyed by anything which interferes with its free access to the air.

The duration of the pupal stage is usually from two to four days, but it may, under unfavorable conditions of temperature, be prolonged to weeks. On the other hand, the threatening danger of a drought or the presence of a disagreeable substance in the water, such as the phinotas oil used for destroying mosquitoes, may very much hasten the emergence of the fly.

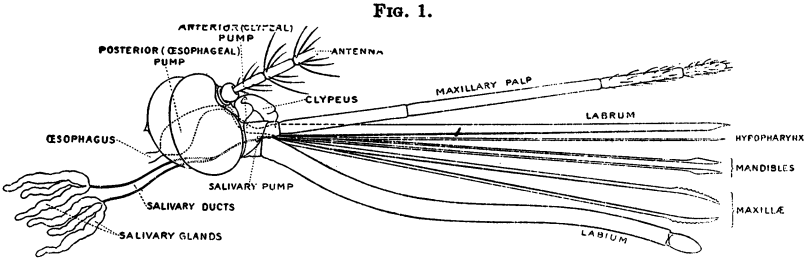
The pupa represents that period in the metamorphosis of the insect during which the internal changes which are begun in the larva which are to result in the formation of the adult mosquito are continued and completed. When the formation is complete, the pupa skin bursts along the middle of the back and the adult extricates itself from its floating case. At this critical period large numbers of mosquitoes perish, because until their legs and wings are thoroughly hardened a slight gust of

wind or a ripple of the water will upset and drown them. This makes it possible to bring about the artificial destruction of a large proportion of the insects through the simple introduction of tide-water into mosquito-ridden marshes.

The body of the mosquito, like that of all other insects, is covered with a dense, though very thin, continuous layer of a hard substance, "chitin." This not only affords protection to the body, but also gives support to the limbs and wing-veins and forms in fact an external skeleton, on the inner side of which the muscles of the insect are attached. Wherever rigidity is required, the chitinous coat is thickened, but elsewhere it remains thin to permit movement of the body segments.

Three main regions of the body may be easily distinguished, the small rounded head with its appendages, the relatively large thorax, and the elongated abdomen. The head, which is connected with the body by

FIG. 1.



means of a rather slender neck, bears the mouth-parts and special sense organs. The thorax bears the organs of locomotion, the legs, one on each segment, the wings on the middle segment, and a pair of minute balancers on the third.

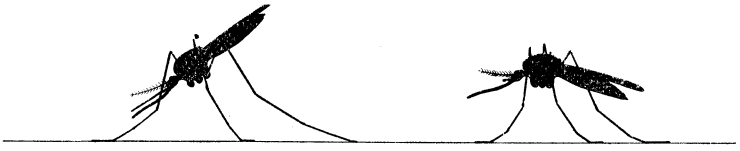
The head bears two large compound eyes, each composed of several thousand simple eyes, so that it is possible for it to see in almost every direction.

In front of the eyes are the antennæ, two slender organs each bearing a whorl of fine hairs. The antennæ are organs of hearing, and by means of them the male is able to detect the presence of the female. If the "song" of a female mosquito be imitated with a tuning fork, the antennæ of the male mosquito, which support long and exceedingly delicate whorls of hairs, that respond to every vibration of the air, may be seen to bend in the direction from which the sound proceeds.

Below the antennæ, at the very front of the head, are the mouth-parts, constituting the so-called "proboscis." This consists of several members. The principal one, lying above all the other mouth-parts,

is the "labrum," deeply grooved along its lower side. Under the labrum there is a delicate chitinous lamella, the "hypopharynx." The hypopharynx is closely applied to the labrum along its entire extent, and by closing the groove therein from below, forms therewith the tube through which the mosquito sucks up blood or other liquid food. A fine tubular channel which runs along the median line of the hypopharynx serves to conduct the poison that the mosquito pours into the wound when sucking blood. Along the sides and below the tube, composed of these two mouth-parts, there are two pairs of very slender chitinous rods, expanded at the ends into lancet-like blades set with fine teeth. One pair, the "mandibles," are exceedingly delicate; the other, the "maxillæ," are stouter and have larger teeth. These latter pairs of instruments enter the wound made by the point of the labrum, and with their saw-like blades serve to brace the head while the "sucking-tube" is thrust for-

FIG. 2.



Anopheles.
BODY AT AN ACUTE ANGLE TO THE SURFACE ON WHICH THE INSECT RESTS.

Culex
BODY PARALLEL TO THE SURFACE ON WHICH THE INSECT RESTS.

ward. By a to-and-fro motion which alternates with that of the piercing tube, they are pushed into the tissues together with the tube, and their fine teeth undoubtedly also serve to lacerate the tissues in the wound and to produce an increased flow of blood at the point of the sucking-tube.

All these mouth-parts, viz.: the labrum, the hypopharynx, the mandibles, and the maxillæ, form a very compact bundle which, when not in action, is almost entirely contained in a groove on the upper surface of the lower lip or "labium." This is attached below the base of the other mouth-parts. It is equal to them in length, but much larger than all the others taken together, and is flexible and forms a sheath which serves for their protection. Its outer surface is beset with scales. Of the whole bundle of mouth-parts only the labium and upper surface of the labrum are ordinarily visible. At the tip of the labium, two small pointed movable flaps, or "labellæ" are hinged which protect the points of all the mosquito's delicate surgical instruments, when these are not in use. In the male the maxillæ are lacking, and the tip of the labrum is blunt and unfit for piercing.

The abdomen tapers gradually toward the tip, and the last segment

in the female mosquito bears the ovipositor by means of which the eggs are laid and, with the aid of the hind legs, arranged on the surface of the water.

The color of the mosquito can be said in general to range from light yellow to dark-brown and almost black.

When the mosquito bites, blood is pumped up into the "sucking-tube" by two pumps. The first and smaller pump lies just above the junction of the labrum with the head and forms a direct continuation with the tube. The second larger and more efficient pump lies further back in the head and is dilated by powerful muscles.

Into the blood in the body cavity of the mosquito, the malarial spores which grow in its stomach wall escape. Through the circulation of the blood the spores then find their way into the salivary or poison glands.

These glands, which supply the irritating poison of the mosquito bite, lie just beyond the neck. The poison from each gland is carried into the head by a fine tube, the salivary duct. In the head the ducts join and the common duct empties into the salivary pump. This in connection with its continuation in the hypopharynx forms a practical syringe by which the poisonous saliva is forced out during the act of feeding. It is by this means that malarial spores are injected into the human circulation.

Malaria was formerly considered to be a form of ague due to foul air, whence its name, which literally means "bad air." It was attributed to a sort of "miasma." Its true nature did not become known till 1880, when Laveran, a French military surgeon working at the time in Algeria, discovered the malarial parasite in human blood. Some years later Professor Manson, of England, directed the attention of Major Ross, of the Indian Service, to the mosquito as a possible carrier of malarial infection. It had at this time just been discovered that yellow fever was spread by mosquitoes, and Manson had previously, in 1879, found a Culex mosquito carrying the parasite of filarial disease. That the insect might play such a direct and extraordinary rôle as it does in the transmission of malaria, was, however, not suspected even by Manson. In 1897 Ross discovered the presence of the malarial organism in a mosquito of the genus *Anopheles,* and a little later, through the efforts, chiefly, of Ross and the Italian, Grassi, the remarkable life history of the parasite became known.

As a result of the laborious researches of these scientists, we now know that malaria is not communicated except by the malaria mosquito, that this is a member of the genus *Anopheles,* and that consequently malaria does not exist in any locality in the absence of mosquitoes of this genus.

That other mosquitoes are likely to imbibe malarial blood is probable but in all others the human malarial parasites or the spores seem to perish in the insect.

When a malaria-infected mosquito bites, the poison which is injected into the wound carries into the human circulation some malarial spores, minute needle-like bodies. Each spore enters a red blood-corpuscle, loses its form, and becomes a rounded amœboid parasite. The corpuscle becomes enlarged and is soon nearly filled by the growing parasite. At the same time the nucleus divides till there are sixteen daughter nuclei.

By the time this nuclear division is complete, almost the entire original contents of the red corpuscle have disappeared, little remaining of it but the thin cell membrane filled with the enlarged parasitic mass. At last the wall of the corpuscle bursts, and the parasite is liberated. Its protoplasm has by this time divided into as many parts as there are nuclei, and each resulting part forms a new spore, which in its turn enters a red blood-corpuscle. The same process of growth at the expense of the blood-cells is then repeated, and new spores are formed by division, accompanied by the destruction of an ever-increasing number of red blood-cells. This process may go on for a considerable period till the blood is filled with billions of the organisms. In time, certain of the spores, after entering fresh corpuscles, do not divide, but develop into forms of the parasite which, if taken up by a malaria mosquito, will reproduce sexually in the insect.

The intervals which separate the paroxysms in malaria correspond in length to the duration of the process of spore formation in the blood-cells, the chills marking the liberation of the spores.

With the extermination of the mosquito of a malarial neighborhood the disease will, in time, disappear. Quinine, obtained from various species of trees of the genus *Cinchona,* growing at high altitudes particularly on the Andes and brought into use in Europe in the year 1640 by the Countess Chinchon, vice-queen of Peru, who had been cured of malaria by its use, is the only known specific against malaria. It will, if properly administered, destroy the parasites of tertian and quartan fever in a comparatively short time. The parasite of tropical fever, however, is only slightly affected by quinine after the parasite has begun to multiply in the blood, though the drug is useful as a preventive.

The malaria mosquito seldom rises even to the second story of a house, and it is a well known fact that persons whose sleeping quarters are high above the ground are seldom attacked by the disease. Since the mosquito is a poor flyer and does not readily rise high above the ground, and since it avoids an abundance of light, its absence from the upper

stories of a building is easily understood. In general, high altitudes insure a freedom from the malaria mosquito and from malaria.

The rôle which mosquitoes play in the dissemination of yellow fever was discovered in 1881 by Dr. Finlay, of Havana, and communicated by him in papers on the "Natural History of Yellow Fever." A suspicion that some insects were concerned in the spreading of the disease had been expressed as early as 1848 by Nott, a physician of Mobile, Alabama. Not much credence, however, was given to Finlay's discovery till it had been firmly established that malaria was transmitted by mosquitoes; and the real experimental proof of transmission by the mosquito was furnished by a commission of United States Army surgeons which was sent to Cuba by former Surgeon-General Sternberg for the purpose of carrying on investigations. The findings of the commission, which was in charge of Major Reed, U. S. A., positively demonstrated that yellow fever was communicated by the bite of a "yellow fever mosquito" (*Stegomyia*) which must previously have fed on the blood of a yellow fever patient; that the fever could not possibly spread without the presence of a mosquito, and that simple contact with a yellow fever patient was not dangerous.

The organism which causes the yellow fever has not, up to the present time, been found; but it is in every way probable that it will prove to be a blood parasite. The period of incubation in man, *i.e.*, the period which must elapse between the bite of the infected mosquito and the beginning of the sickness, varies from forty-one hours to not more than six days. The period of its development in the mosquito was found by the commission to be twelve days or more. This fact is of very great importance in relation to quarantine measures, and makes it entirely possible to prevent the introduction of yellow fever into any port where it does not exist.

The yellow fever mosquito is known as a "day mosquito." The back of the thorax is marked by silvery stripes, the dark-brown or black sides of both thorax and abdomen are ornamented with conspicuous white spots, and each segment of the abdomen bears a white cross-stripe. The knee-spots of the black legs are white, and the tarsal joints are banded with white. These markings make the mosquito quite easy to recognize.

This knowledge of disease-producing parasites and of the insects that transmit them furnishes a scientific basis for such quarantine and preventive measures as are being carried out by our government at Panama, and to some extent by other nations in other places. Such campaigns of extermination as are now being carried on would in the past have seemed not only extravagant but insane.

To cope with the problem of extermination, efforts must be directed toward the extermination of the insects in the larval and pupal stages. Mosquitoes have some natural enemies. Night-prowling birds eat the mature insect; while the larvæ form the food of some shore birds, insects, and fish.

The use of crude petroleum spread as a thin film on the surface of a body of water has long been known to kill the larvæ and pupæ, but it is applicable only to small bodies of water, and it is not lasting in its effect. Poisoning of the water must naturally be restricted in its application, but it is effective, and of the agents tried, "phinotas oil," which is highly diffusible, is found to give much the best results. Cisterns, rain barrels, and other receptacles in which mosquitoes are apt to breed in large numbers and in which poisoning of the water is not permissible, should be kept covered, while other mosquito-breeding collections of water in which fish cannot be used should be treated by drainage or filling.

THE NORTHERN-MOST FLOATING HOSPITAL

By FELIX J. KOCH

THE question would have been a stumper to us, surely. "Where is the floating hospital that plies farthest north on the Atlantic sea-board?" We investigated and found that as few knew as we did.

We recalled a floating hospital off Winthrop, in Massachusetts Bay, one summer. We did not recall any at Halifax or up the Canadian coast, at least that we had run into. Finally when we came to Newfoundland and embarked for the Labrador we discovered it.

There is but one boat that plies as far as Nain on the Labrador coast and that a filthy sealing steamer known as the *Virginia Lake*. Twice a year this runs as far as Nain, the northern-most limit of regular navigation of the Atlantic. Twice a year it goes to Davis Inlet, not quite so far, and fortnightly it plies to other more southerly ports.

Up on the coast of Labrador there live, in the summer, from twenty to thirty thousand fishermen,—these and the schooner girls who "keep house" for them. For these folk there is no doctor save only when Dr. Grenfell of *Deep Sea Mission* fame happens to drop into the fiord with his hospital ship. The government, however, has come, in a way, to the relief by providing that aboard the *Lake,* which is the mailboat, there is stationed a doctor who dispenses both services and drugs free, to the fishermen.